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UCRL-TR-206882

# Ultrasonic Calibration Wire Test Phantom

S. K. Lehman, K. A. Fisher, M. Werve, D. H.  
Chambers

September 29, 2004

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# Ultrasonic Calibration Wire Test Phantom

Sean K. Lehman, Karl A. Fisher, Mick Werve, David H. Chambers

February 15, 2005

## **Abstract**

We designed and built a phantom consisting of vertical wires maintained under tension to be used as an ultrasonic test, calibration, and reconstruction object for the Lawrence Livermore National Laboratory annular array scanner. We provide a description of the phantom, present example data sets, preliminary reconstructions, example metadata, and MATLAB codes to read the data.

**UCRL-TR-206882**

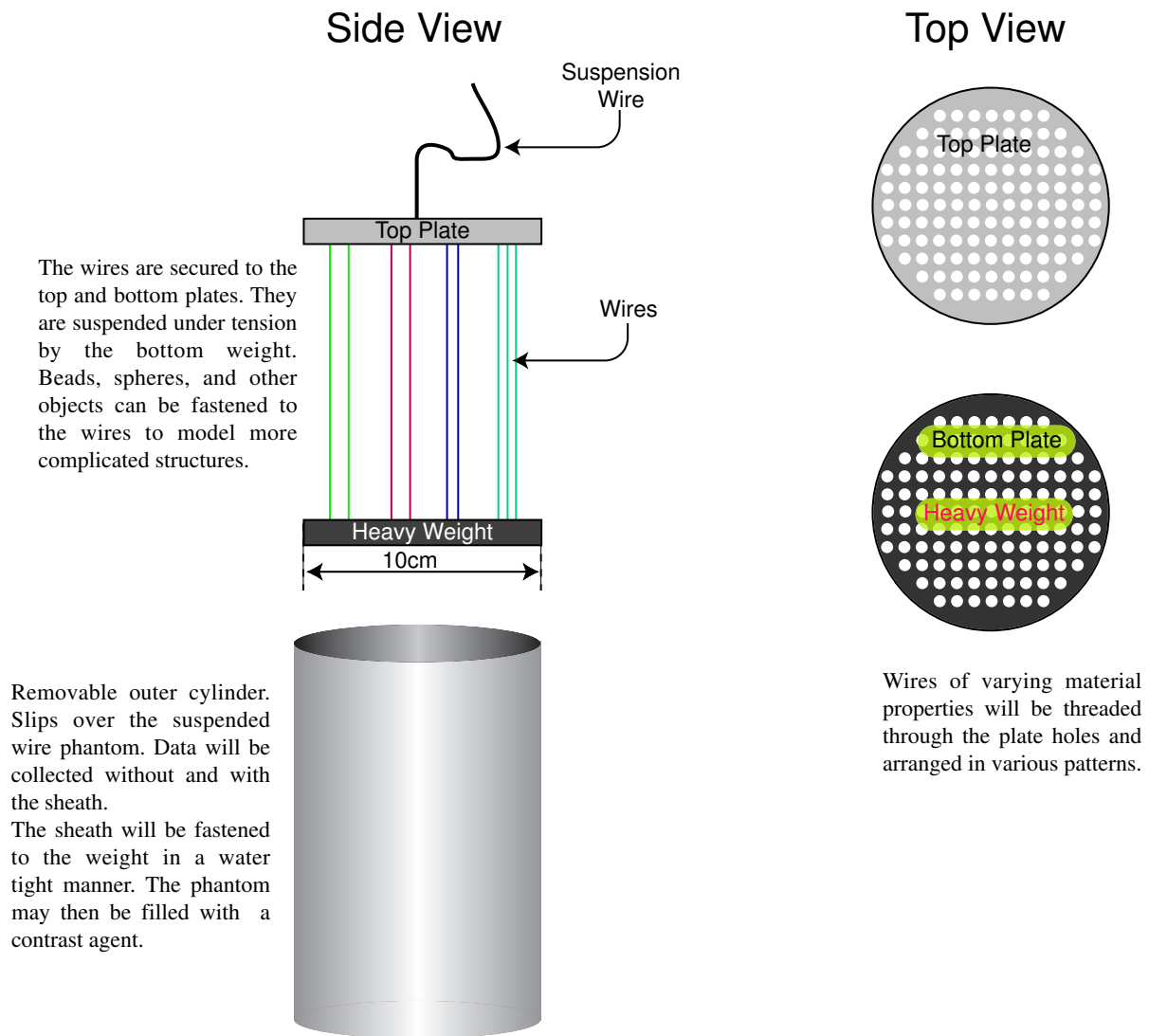


Figure 1: *Preliminary wire phantom conceptual design.*

# 1 Introduction

We designed and built a reconfigurable wire phantom for the ultrasonic Lawrence Livermore National Laboratory annular array scanner. We collected well characterized data under controlled conditions for use as “canonical data sets” in testing and evaluating new inversion algorithms.

The phantom consists of vertical wires maintained under tension. The planar,  $(x, y)$ , wire distribution is governed by holes drilled through upper and lower wire guide plates in a selected geometric pattern. The wires are threaded through the holes and secured to mounting brackets. Given that the phantom object formed by the wire distribution does not vary much in the vertical ( $z$ -direction), we assume the measured data form a 2.5-dimensional object. The initial conceptual phantom design is presented in Figure 1

These plates are removable permitting differing designs to be used. We currently only have one design: a logarithmic spiral with equation,

$$\mathbf{r}(\theta_n) = a (\cos(\theta_n), \sin(\theta_n)) e^{b\theta_n}, \quad (1)$$

where

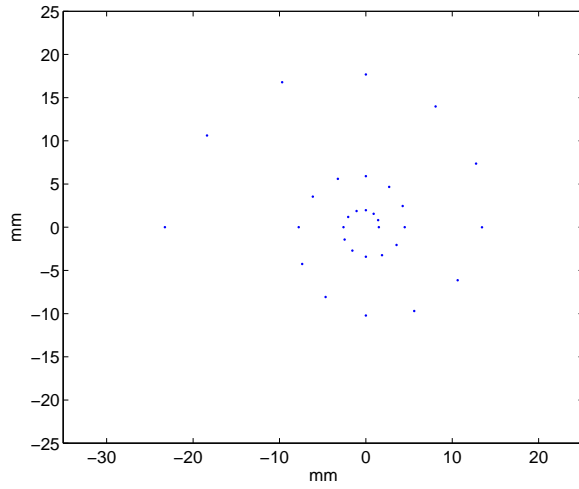
$a \equiv \lambda_0$	is the initial radius and,
$\lambda_0 \equiv v_0/f_0$	is the insonifying wavelength,
$v_0 \equiv 1500$ meters/second	is the assumed background water velocity,
$f_0 \equiv 1$ MHz	is the approximate insonifying frequency,
$b \equiv 10\pi/180$	is the spiral growth rate,
$\theta_n \equiv \{n\Delta\theta\}_{n=0}^{N-1}$	are the angular locations of the wires,
$\Delta\theta \equiv 30\pi/180$	is the angular increment,
$N \equiv 31$	is the number of wires.

This current configuration is shown in Figure 2(a). We have allowed for an optional acrylic hollow cylinder around the phantom as shown in Figure 2(b). Figure 2(c) shows one of the plates. The  $(x, y)$  locations of the wires in the logarithmic spiral are listed in Table 1. Figure 3 shows a graphic of the phantom in relation to the transducer locations.

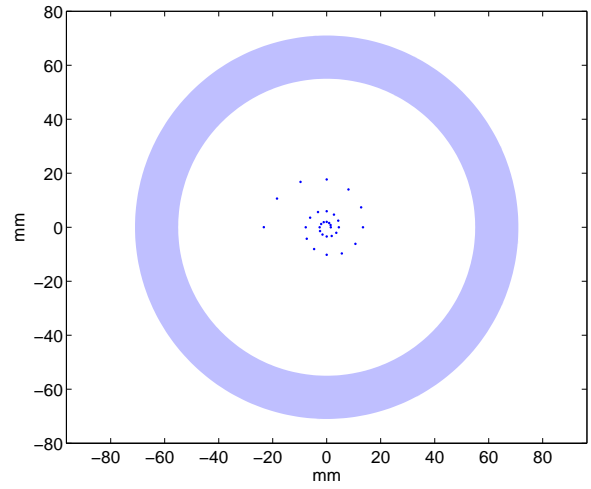
Figures 4 and 5 show the phantom under construction while being installed in the scanner. The top block is affixed to a rod fastened to the central bore of the scanner drive; the bottom block is fastened to the bottom of the tank. Figure 6 (a) shows the phantom with 31 taut steel wires. Figure 6 (b) shows the optional acrylic cylinder in place.

The design of the phantom allows for wires of different materials to be used. We have run scans with the following combinations:

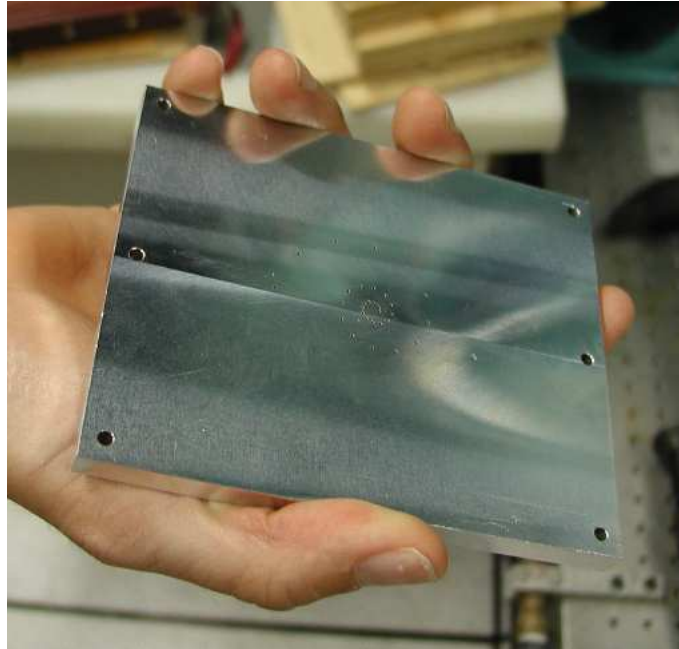
- 31 steel wires;
- 30 steel, 1 nylon;
- 25 steel, 6 nylon;
- 25 steel, 6 nylon, with the hollow cylinder;
- 2 steel, 2 nylon resolution pair;
- 2 steel, 2 nylon resolution pair, with the hollow cylinder;
- Water background (no wires);



(a)



(b)



(c)

Figure 2: *Basic spiral phantom design. (a) Without hollow cylinder. (b) With cylinder. (c) Photograph of wiring plate with holes.*

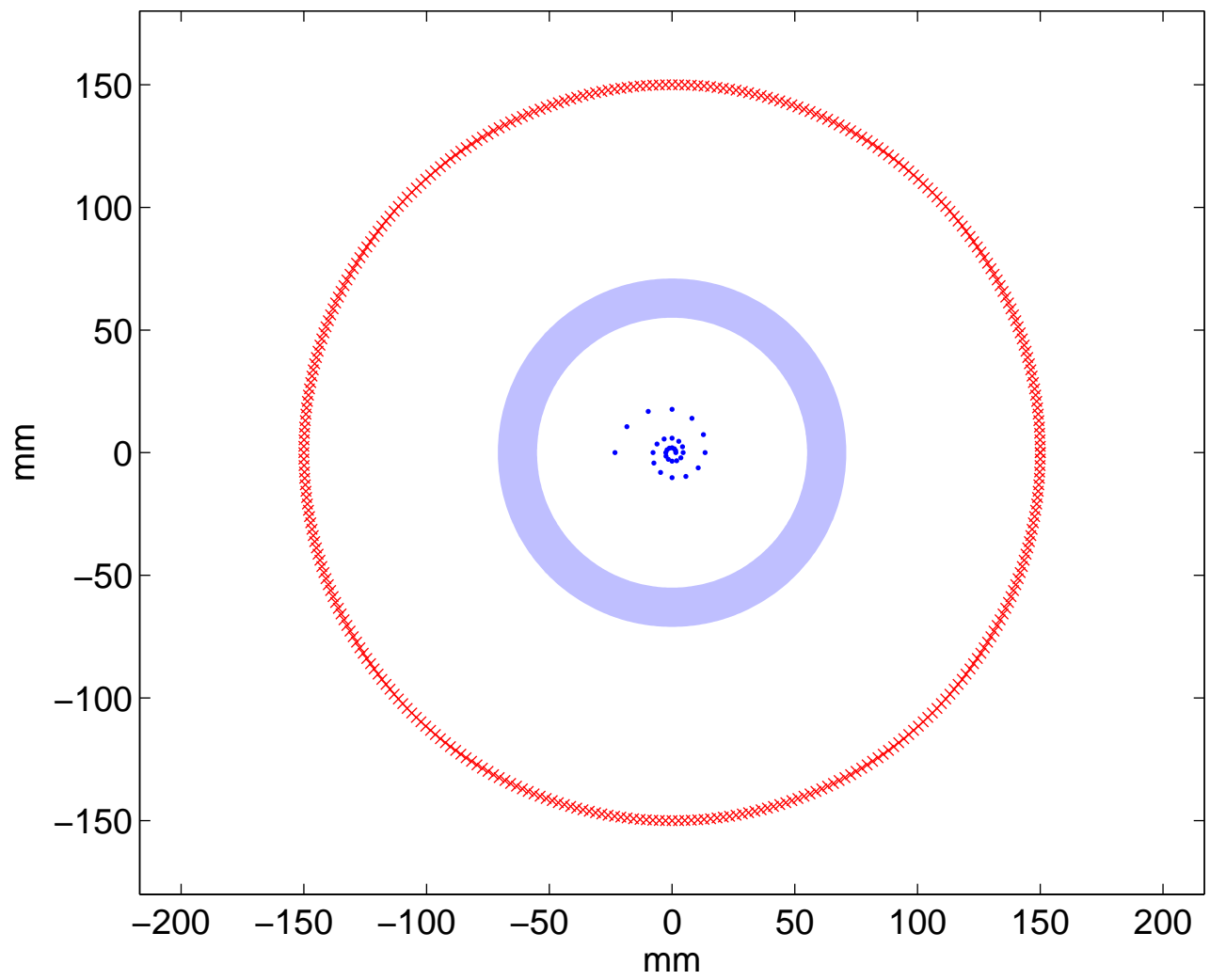


Figure 3: *Graphic showing phantom in relation to transducer array location.*



Figure 4: *Phantom under construction during installation in ultrasonic LLNL annular array scanner.*

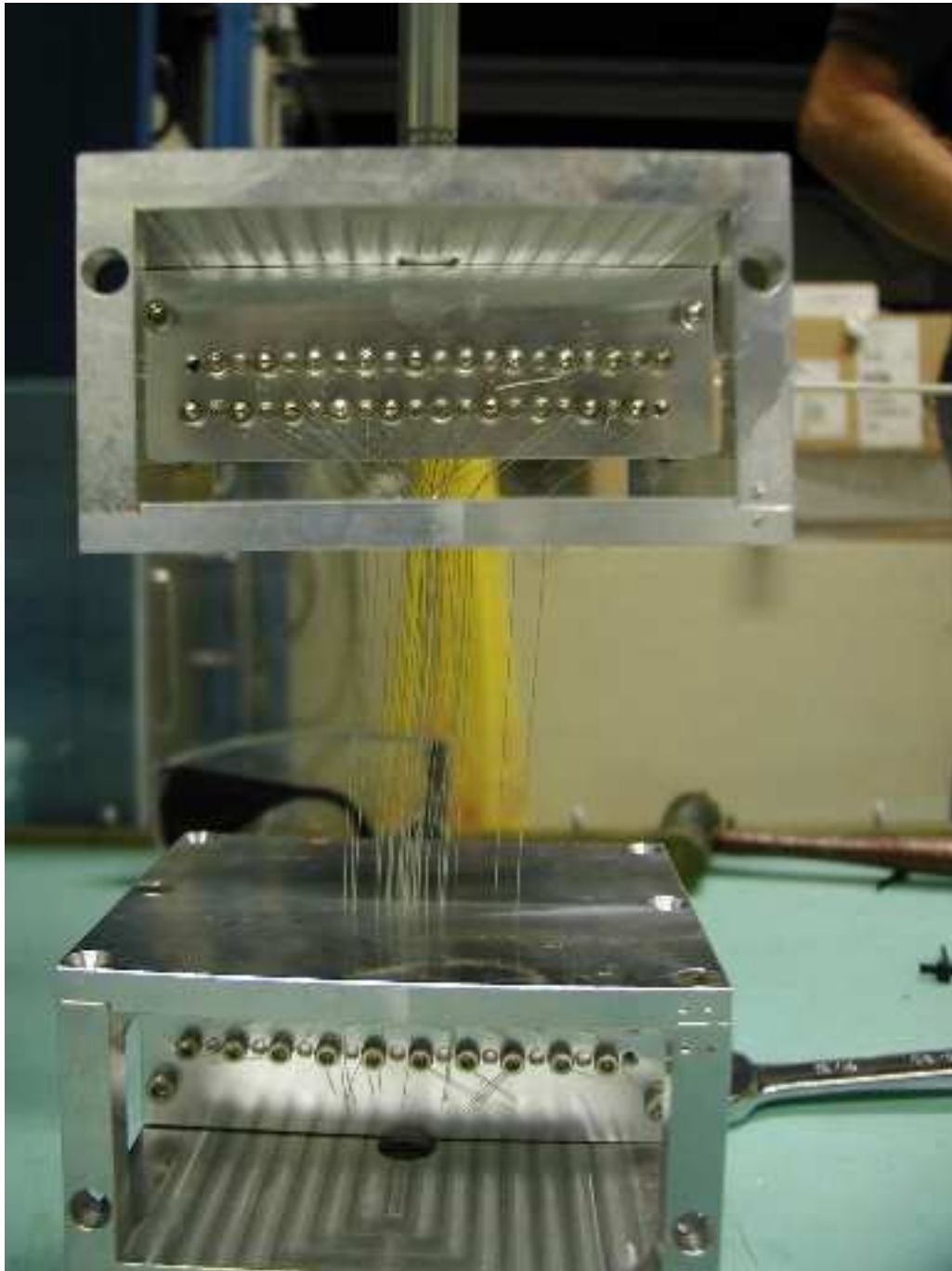
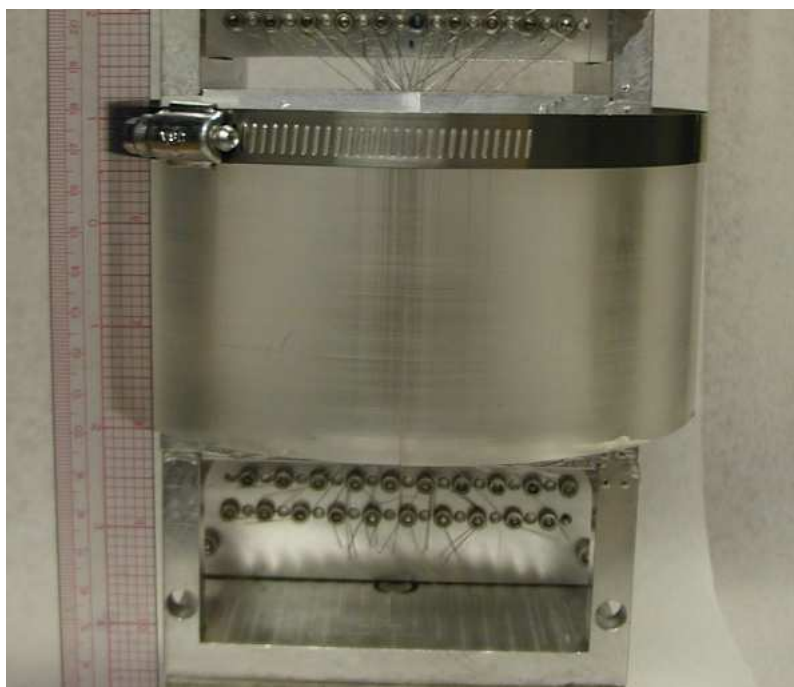


Figure 5: *Detail of phantom before wires were pulled taut.*



(a)



(b)

Figure 6: (a) *Phantom after the wires were pulled taut.* (b) *Phantom with optional acrylic hollow cylinder.*

$x$	$y$	$x$	$y$
1.5000	0.0000	-3.2365	5.6057
1.4233	0.8218	-6.1421	3.5462
0.9004	1.5595	-7.7710	0.0000
0.0000	1.9731	-7.3739	-4.2573
-1.0810	1.8723	-4.6647	-8.0795
-2.0515	1.1844	-0.0000	-10.2221
-2.5955	0.0000	5.6001	-9.6997
-2.4629	-1.4219	10.6279	-6.1360
-1.5580	-2.6985	13.4464	-0.0000
0.0000	-3.4142	12.7592	7.3665
1.8704	-3.2397	8.0715	13.9802
3.5497	-2.0494	0.0000	17.6876
4.4911	-0.0000	-9.6901	16.7837
4.2615	2.4604	-18.3898	10.6174
2.6958	4.6693	-23.2667	0.0000
0.0000	5.9076		

Table 1:  $(x, y)$  location of wires in millimeters for the logarithmic spiral.

- Hollow cylinder only (no wires).

Example data sets showing measured time series and spectral data are presented in Figures 7 through 10. The data are very clean and have good contrast. Clear and distinct sinograms of individual wires are seen in the steel wire data set of Figure 7.

## 2 Scanner and Data Collection Details

The LLNL ultrasonic scanner consists of two independently operating transducers which orbit about a common center. They are programmed to synthesize a fully multistatic annular array. The data sets described herein were collected using the following parameters:

- Two independently scanning transducers;
- 320 receiver locations;
- 361 transmitter locations;
- One degree increment;
- 15 cm radius;
- Two cycles of a sine input voltage;
- 1.6 MHz center frequency;
- 15 MHz sample rate;
- 4096 element time record;

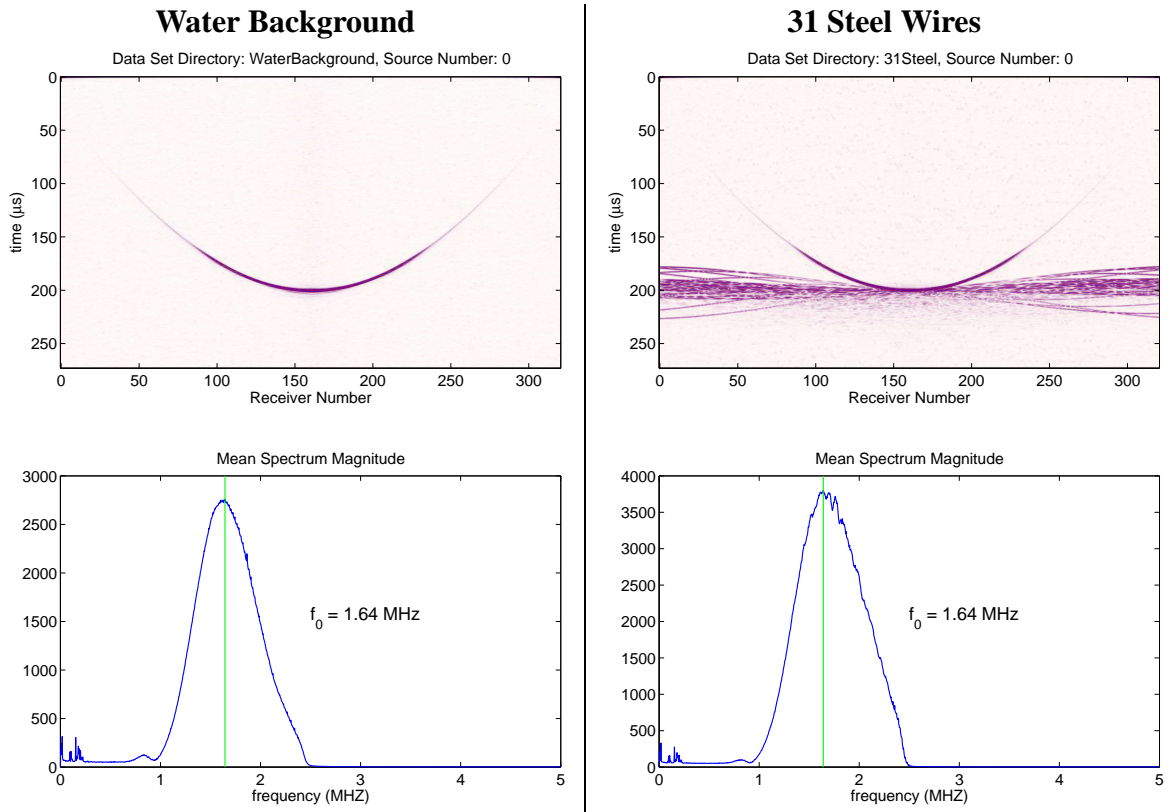


Figure 7: Example water background and 31 steel wire data sets.

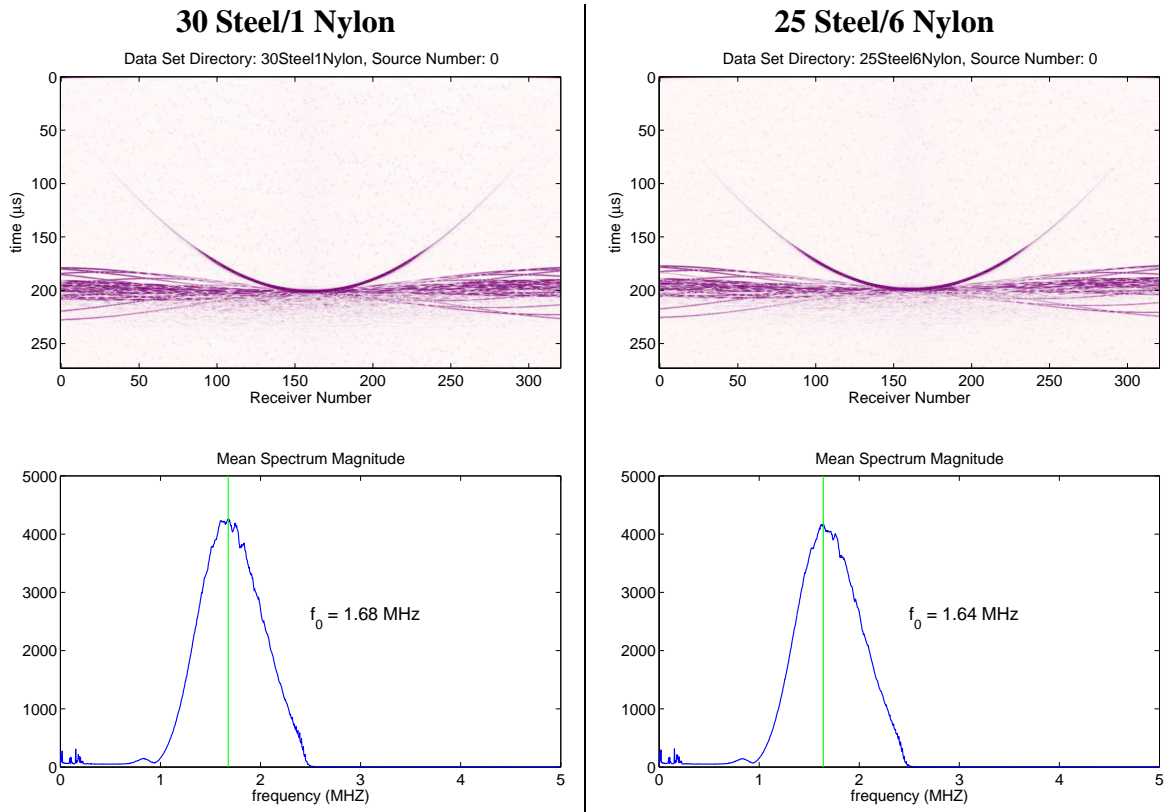


Figure 8: *Example 30 steel/1 nylon and 25 steel/6 nylon data sets.*

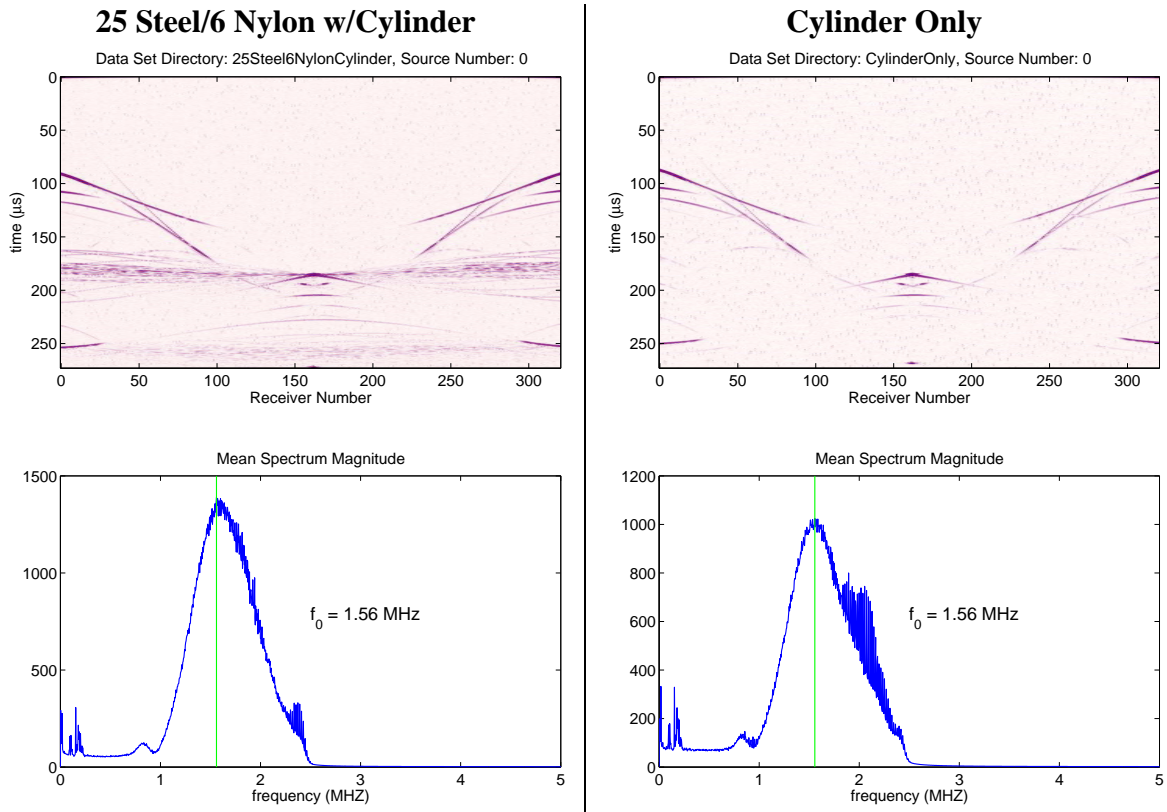


Figure 9: *Example 25 steel/6 nylon and cylinder only data sets.*

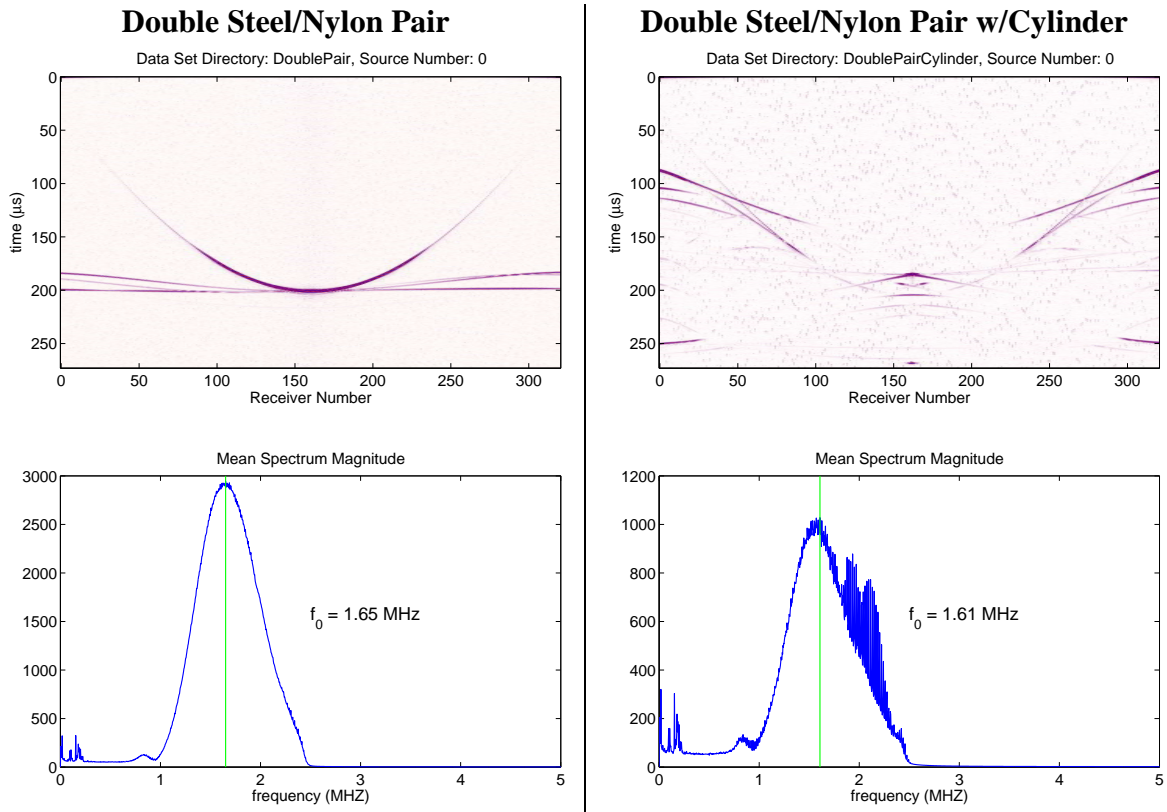


Figure 10: Example double pair data sets.

- Multistatic data.

The complete data set for a single run are stored in a directory whose name describes the phantom configuration. For each run there are 361 text files with extension `.txt` which contain the metadata and a corresponding number of binary data files with extension `.bin` which contain the time series data. The files are labeled 000 through 360 corresponding to the index of the transmitter angular location.

### 3 MATLAB Codes to Read Data

The following MATLAB codes are provided to read and perform a “quick look” through the data:

`ResolveFilename.m` Used to resolve a data set and transmitter index into a full path name;

`flipthroughllnlusdata.m` Provides a “quick look” through an entire data run;

`hdr2param.m` Converts a raw metadata header into a header suitable for use in a reconstruction algorithm;

`rdllnlusdata.m` Reads one or more transmitter data sets;

`rdllnlusheader.m` Reads a single header file.

10/08/04 10:51:09	matlab/ResolveFilename.m	1
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```
function Filename = ResolveFilename( Basename , srcno , ext )
%*****
%
% TITLE:      ResolveFilename( Basename , srcno , ext )
% AUTHOR:    Sean K. Lehman
% DATE:      September 28, 2004
% FUNCTION:  Resolve a basename, including a directory, into a
%            correct LLNL annular array ultrasonic scanner name
% SYNTAX:    fname = ResolveFilename( Basename , srcno , ext )
%
%            FNAME      : Returned full path file name.
%            BASENAME   : Input base directory name.
%            SRCNO      : Source number (0-360).
%            EXT        : Extension, either '.txt' or '.bin'.
%
% MODIFICATIONS:
%
%
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%       of California. All rights reserved.
%
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% National Laboratory. The United States Government
% retains certain rights therein.
%
%*****/
% Remove trailing '//':
bname = Basename;
if bname(end)=='/' ; bname(end)=0; end

Filename = sprintf('%s/%d.%s',bname,srcno,ext);
if exist( Filename , 'file' ); return ; end

Filename = sprintf('%s/%03d.%s',bname,srcno,ext);
if exist( Filename , 'file' ); return ; end
```

```

function flipthroughllnlusdata( Basename , Pause )
%*****
%
% TITLE:      flipthroughllnlusdata.m
% AUTHOR:     Sean K. Lehman
% DATE:       October 08, 2004
% FUNCTION:   Flip through a complete LLNL ultrasonic annular array
%             data set
% SYNTAX:     flipthroughllnlusdata( Basename )
%             flipthroughllnlusdata( Basename , Pause )
%
% MODIFICATIONS:
%
%
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%
%*****/

Filename = ResolveFilename( Basename , 0 , 'txt' );
h = hdr2param( rdllnlusheader( Filename ) );
us = 1e-6;
time = h.time / us;
rcvno = [0:h.Nrcv-1];
fetchfigure( Basename ); clf
for srcno = 0:h.Nsrc-1
    data = rdllnlusdata( Basename , srcno );
    imagesc(rcvno,time,data)
    set(gca,'fontsize',18)
    xlabel('Receiver Number'); ylabel('time (\mus)')
    title(sprintf('%s: Source %d',Basename,srcno))
    pause( Pause )
end

function fig = fetchfigure( FigureName )
%*****
%
% TITLE:
% AUTHOR:     Sean K. Lehma
% DATE:       July 08, 2004
% FUNCTION:
% SYNTAX:
%
% MODIFICATIONS:
%
%
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%
%*****/
h = get(0,'children');
fig = -1;
for n=1:length(h),
    if strcmp( get(h(n),'name') , FigureName ),
        fig = h(n);
    end
end
if fig==-1 % Create new window
    fig = figure('Name',FigureName);
end

```

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11:27:10

matlab/flipthroughlilusdata.m

2

`figure(fig)`

```

function param = hdr2param( header )
%*****
%
% TITLE:      hdr2param.m
% AUTHOR:     Sean K. Lehman
% DATE:       January 30, 2003
% FUNCTION:   Convert a raw LLNL annular array ultrasonic scanner
%             header structure as read from the .txt file into a
%             parameter structure with information useful for
%             processing the data.
%
% SYNTAX:     param = hdr2param( header )
%
% PARAM      : Returned parameter structure:
%               Nrcv: Number of receivers
%               Nsrc: Number of sources
%               Nt: Number of time steps
%               dt: Time sample interval
%               time: Time step array
%               dsrc: Source angular increment
%               src0: Initial source angular location
%               drcv: Receiver angular increment
%               rcv0: Initial receiver angular location
%               Radius: Array radius in mm
%               srcarg: Array of source angular locations
%               Rsrc: Cartesian source (x,y) locations
%               rcvarg: Array of receiver angular locations
%               Rrcv: Cartesian receiver (x,y) locations
%
% HEADER     : Input raw header structure as returned by
%               rdllnlusheader.m or rdllnlusdata.m
%
% MODIFICATIONS:
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%
%*****/
MHz = 1.e6;
cm = 1.e-2;
mm = 1.e-3;
ms = 1.e-3;
us = 1.e-6;
rad = pi / 180;

Nrcv = header.RxPositions;
Nsrc = header.TxPositions;
Nt = header.RxTimeSamples;
dt = 1/(header.RxSampFreq * MHz);
time = [0:Nt-1]*dt;
rad = pi / 180;
dsrc = header.TxIncr * rad;
src0 = (header.TxThetaStart+header.TxThetaPos) * rad;
drcv = header.RxIncr * rad;
rcv0 = (header.RxThetaStart+header.TxThetaPos) * rad;
Radius = header.DeviceRadiusM * mm;
arg = src0 + [0:Nsrc-1]'*dsrc;
Rsrc = Radius * [ cos(arg) sin(arg) ];
arg = rcv0 + [0:Nrcv-1]'*drcv;
Rrcv = Radius * [ cos(arg) sin(arg) ];

param = struct('Nrcv' , Nrcv , ...
               'Nsrc' , Nsrc , ...
               'Nt' , Nt , ...

```

```
'dt'      , dt      , ...  
'time'    , time    , ...  
'dsrc'    , dsrc    , ...  
'src0'    , src0    , ...  
'drcv'    , drcv    , ...  
'rcv0'    , rcv0    , ...  
'Radius'  , Radius  , ...  
'srcarg'  , src0 + [0:llsrc-1]'*dsrc, ...  
'Rsrc'    , Rsrc    , ...  
'rcvarg'  , rcv0 + [0:llrcv-1]'*drcv, ...  
'Rrcv'    , Rrcv   );
```

```

function [data,header] = rdllnlusdata( Basename , Sources , ByteOrder )
%*****
% TITLE:      rdllnlusdata.m
% AUTHOR:     Sean K. Lehman
% DATE:       November 27, 2002
% FUNCTION:   Read raw LLLL annular array ultrasonic scanner data and header
% SYNTAX:     [data,header] = rdllnlusdata( Basename )
%             [data,header] = rdllnlusdata( Basename , Sources )
%             [data,header] = rdllnlusdata( Basename , Sources , ByteOrder )
%
%             DATA      : Nt by Nrcv by Nsrc matrix of time series data
%             HEADER     : Raw LLLL annular array ultrasonic scanner
%                           data and header.
%                           Convert raw header to a useful parameter
%                           structure via hdr2param.m
%             BASENAME   : Input base directory name
%             SOURCES    : Can be a single source or array of selected sources
%                           to be read.
%                           If absent, all sources are read.
%             BYTEORDER  : Byte order. It is always ieee-le and need
%                           not be set.
%
% MODIFICATIONS:
%
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%*****

Filename = ResolveFilename( Basename , 0 , 'txt' );
h        = rdllnlusheader( Filename );

if isempty( h )
    fprintf(1,'Uable to read header file: %s\n',Filename);
    data = [];
    return;
end

switch nargin
case 1
    Nsrc      = h.TxPositions ;
    Sources   = 0:Nsrc-1;
    byteorder = 'ieee-le' ;

case 2
    if length(Sources) > 0
        Nsrc = length(Sources);
    else
        Nsrc = h.TxPositions ;
        Sources = 0:Nsrc-1;
    end
    byteorder = 'ieee-le' ;

case 3
    if length(Sources) > 0
        Nsrc = length(Sources);
    else
        Nsrc = h.TxPositions ;
        Sources = 0:Nsrc-1;
    end
    byteorder = ByteOrder;

end

```

```

LastSrc = h.TxPositions ;
Nrcv    = h.RxPositions ;
Nt      = h.RxTimeSamples ;
data    = zeros(Nt,Nrcv,Nsrc);

switch h.DataPrecision
case 5
    prec = 'uint16';
    prec = 'int32';
    prec = 'int16';
otherwise
    fprintf(1,'Unsupported data type. Include it in rdllnlusdata.m\n');
    data = [];
    return;
end

if 0
    fprintf(1,' Nsrc : %d\n',Nsrc);
    fprintf(1,' Nrcv : %d\n',Nrcv);
    fprintf(1,' Nt   : %d\n',Nt);
end

ns = 1;
for srcno = Sources
    DataFilename = ResolveFilename(Basename,srcno,'bin');
    HeaderFilename = ResolveFilename(Basename,srcno,'txt');
    fprintf(1,'Reading %s\n',DataFilename);
    h = rdllnlusheader( HeaderFilename );
    fid = fopen( DataFilename , 'r' , byteorder );
    if fid == -1
        fprintf(1,'Uable to open "%s"\n',DataFilename);
        data = [];
        return;
    end
    header(ns) = h;
    clear h;

    d = fread(fid,[Nt Nrcv],prec);
    fclose( fid );

    m = mean( d , 1 );
    data(:, :, ns) = d - ones(Nt,1)*m;

%
% If the rotation is "clockwise," change the sign on the reciever increment
% and swap the receiver start and stop angles.
%
    if header(ns).RxIncr < 0
        data(:, :, ns) = fliplr( data(:, :, ns) );
        header(ns).RxIncr = -header(ns).RxIncr ;
        temporary = header(ns).RxThetaStart ;
        header(ns).RxThetaStart = header(ns).RxThetaStop ;
        header(ns).RxThetaStop = temporary ;
    end
    ns = ns + 1;
end

```

```

function header = rdllnlusheader( Filename )
%*****
%
% TITLE:      rdllnlusheader.m
% AUTHOR:     Sean K. Lehman
% DATE:       November 27, 2002
% FUNCTION:   Read raw LLNL annular array ultrasonic scanner header
% SYNTAX:     Header = rdllnlusheader( Filename )
%
%           HEADER : Raw LLNL annular array ultrasonic scanner
%                   data and header.
%                   Convert raw header to a useful parameter
%                   structure via hdr2param.m
%           FILENAME : The full file name, including the extension,
%                   of the header file.
%
% MODIFICATIONS:
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%           National Laboratory. The United States Government
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%
%*****/
fid = fopen( Filename , 'r' );

if fid == -1
    fprintf(1,'Unable to open "%s"\n',Filename);
    header = [];
    return;
end

[a,b]= textread( Filename , '%s%^\n' , -1 , 'commentstyle' , 'matlab','delimiter','\n' );

fclose( fid );

Na = length(a);
for n=1:Na
    s = char( a(n) );
    k = find( s ~= ' ' );
    s = s( k );
    a{n} = s;
end

header = cell2struct( b , a , 1 );

if ~isfield(header,'BadScanLines')
    header.BadScanLines = '0';
end
if ~isfield(header,'ChecksumErrors')
    header.ChecksumErrors = '0';
end

header = ConvertHeaderStrings2Num( header );

function h = ConvertHeaderStrings2Num( hin )
h = hin ;
h.DeviceRadiusUT = str2num(hin.DeviceRadiusUT);
h.DeviceRadiusM = str2num(hin.DeviceRadiusM);
h.TxZPositions = str2num(hin.TxZPositions);
h.TxZPos = str2num(hin.TxZPos);
h.TxZStart = str2num(hin.TxZStart);
h.TxZStop = str2num(hin.TxZStop);

```

```
h.TxZIncr          = str2num(hin.TxZIncr) ;
h.TxThetaPos       = str2num(hin.TxThetaPos) ;
h.TxThetaStart     = str2num(hin.TxThetaStart) ;
h.TxThetaStop      = str2num(hin.TxThetaStop) ;
h.TxIncr           = str2num(hin.TxIncr) ;
h.TxPositions      = str2num(hin.TxPositions) ;
h.TxTBCycles       = str2num(hin.TxTBCycles) ;
h.TxTBPhase        = str2num(hin.TxTBPhase) ;
h.TxTBFreq         = str2num(hin.TxTBFreq) ;
h.TxTBVolts        = str2num(hin.TxTBVolts) ;
h.TxTBVOffset      = str2num(hin.TxTBVOffset) ;
h.RxZPositions     = str2num(hin.RxZPositions) ;
h.RxZPos           = str2num(hin.RxZPos) ;
h.RxZStart         = str2num(hin.RxZStart) ;
h.RxZStop          = str2num(hin.RxZStop) ;
h.RxZIncr          = str2num(hin.RxZIncr) ;
h.RxThetaStart     = str2num(hin.RxThetaStart) ;
h.RxThetaStop      = str2num(hin.RxThetaStop) ;
h.RxIncr           = str2num(hin.RxIncr) ;
h.RxPositions      = str2num(hin.RxPositions) ;
h.RxAmpGain1       = str2num(hin.RxAmpGain1) ;
h.RxAmpGain2       = str2num(hin.RxAmpGain2) ;
h.RxAtten1         = str2num(hin.RxAtten1) ;
h.RxAtten2         = str2num(hin.RxAtten2) ;
h.RxNetGain        = str2num(hin.RxNetGain) ;
h.RxTimeSamples    = str2num(hin.RxTimeSamples) ;
h.RxSampFreq       = str2num(hin.RxSampFreq) ;
h.RxVolts          = str2num(hin.RxVolts) ;
h.Temperature      = str2num(hin.Temperature) ;
h.TempTime         = str2num(hin.TempTime) ;
h.DataPrecision    = str2num(hin.DataPrecision) ;
h.NumDataPoints    = str2num(hin.NumDataPoints) ;
h.BadScanLines     = str2num(hin.BadScanLines) ;
h.CheckSumErrors   = str2num(hin.CheckSumErrors) ;
```

## 4 Typical Metadata File

10/11/04  
09:48:28

3lSteel/010.txt

1

```
%LLNL Ultrasound Tomographic Scanner
File Version: 6.0
%Steve Benson, 12-05-00
%Agilent 33250A

FileName:      CensusPhantom_0_XT_10.txt
ScanDate:      08-24-2004
ScanTime:      8:39:26

%Object Description
ODLine1:       8/18/04  Censis Phantom Smile
ODLine2:       Pasternack and filter in
ODLine3:       New Reciever Cabling
ODLine4:

%Transmitter Description
TDLine1:       Ultrason 5x12.5mm line activated
TDLine2:       WS100-0.5-X
TDLine3:       230736
TDLine4:       Replacement ENI (Model 325LA) Installed Serial #731662

%Receiver Description
RDLine1:       Ultrason 5x12.5mm line activated
RDLine2:       WS100-0.5-X
RDLine3:       230737
RDLine4:       NO CABLES THRU THE MACHINE

BaseFileName:  i:\WirePhantom\ScanOne\CensusPhantom_
DeviceRadiusUT: 147.85974121
DeviceRadiusM: 150.00000000

TxZPositions:  1
TxZPos:        0.000
TxZStart:      0.000
TxZStop:       0.000
TxZIncr:       0.000
TxThetaPos:    10.00000000
TxThetaStart:  0.00000000
TxThetaStop:   360.00000000
TxIncr:        1.00000000
TxPositions:   361
TxAmp:         ENI_240L_RP_Amp
TxTBCycles:    2
TxTBPPhase:    0.00000000
TxTBPFreq:     1.70000000
TxTBVVolts:    1.00000000
TxTBVOffset:   0.00000000

RxZPositions:  1
RxZPos:        0.000
RxZStart:      0.000
RxZStop:       0.000
RxZIncr:       0.000
RxThetaStart:  20.00000000
RxThetaStop:   340.00000000
RxIncr:        1.00000000
RxPositions:   321
RxAmp1:        None
RxAmpGain1:    40.00000000
RxAmp2:        None
RxAmpGain2:    34.00000000
RxAtten1:      0.00000000
RxAtten2:      32.59999847
RxOffsetGain:  41.40000153
RxTimeSamples: 4096
RxSampFreq:    15.00000000
RxVolts:       3.00000000
```

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31Steel/010.txt

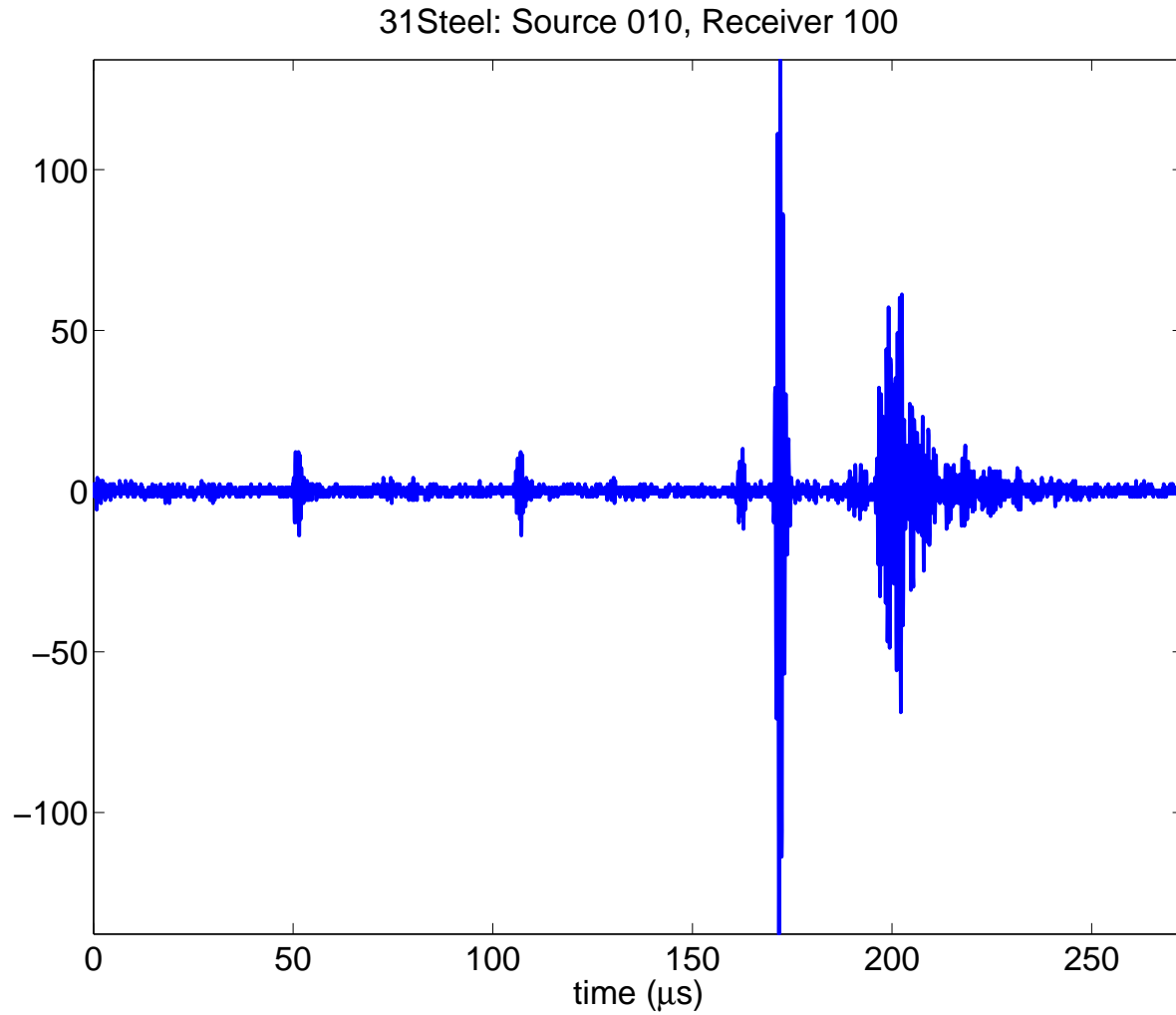
2

Temperature: 211.95605469  
TempTime: 1019.15500000

DataPrecision: 5  
NumDataPoints: 1314816

## 5 Listing of Typical Data File

The listing of the data set graphed here represents a typical received time series.



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1

0.204834	2.20483	1.20483	2.20483	-1.79517	-1.79517	-1.79517
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4.20483	0.204834	-2.79517	-0.795166	2.20483	3.20483	3.20483
-0.795166	0.204834	3.20483	0.204834	2.20483	2.20483	-3.79517
-3.79517	2.20483	3.20483	1.20483	-1.79517	-0.795166	1.20483
3.20483	1.20483	-1.79517	-1.79517	-0.795166	1.20483	2.20483
-0.795166	-1.79517	-2.79517	2.20483	1.20483	1.20483	-1.79517
-0.795166	1.20483	1.20483	-0.795166	-1.79517	-0.795166	0.204834
1.20483	1.20483	-0.795166	-0.795166	0.204834	2.20483	1.20483
0.204834	-2.79517	-0.795166	1.20483	2.20483	1.20483	0.204834
0.204834	0.204834	1.20483	2.20483	0.204834	-0.795166	0.204834
2.20483	0.204834	-0.795166	-1.79517	0.204834	-0.795166	1.20483
0.204834	0.204834	-0.795166	0.204834	1.20483	0.204834	-0.795166
0.204834	1.20483	1.20483	1.20483	1.20483	-0.795166	0.204834
3.20483	0.204834	0.204834	-0.795166	-1.79517	0.204834	2.20483
0.204834	0.204834	1.20483	1.20483	-0.795166	0.204834	0.204834
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-0.795166	3.20483	0.204834	0.204834	0.204834	0.204834	0.204834
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0.204834	3.20483	0.204834	-0.795166	-0.795166	0.204834	0.204834
0.204834	1.20483	-1.79517	-0.795166	1.20483	2.20483	0.204834
0.204834	-0.795166	-1.79517	-0.795166	2.20483	0.204834	0.204834
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-0.795166	1.20483	-0.795166	-0.795166	0.204834	1.20483	0.204834
1.20483	-0.795166	-0.795166	-1.79517	2.20483	1.20483	0.204834
-0.795166	-0.795166	0.204834	1.20483	-1.79517	-0.795166	-0.795166
0.204834	-0.795166	0.204834	0.204834	-2.79517	-0.795166	-0.795166
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0.204834	-0.795166	0.204834	1.20483	0.204834	0.204834	-1.79517
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0.204834	-0.795166	-1.79517	1.20483	2.20483	-0.795166	-0.795166
0.204834	-0.795166	-1.79517	0.204834	0.204834	0.204834	0.204834
-0.795166	-0.795166	1.20483	2.20483	0.204834	-0.795166	1.20483
1.20483	-0.795166	-0.795166	-1.79517	-0.795166	-0.795166	1.20483
0.204834	0.204834	0.204834	-0.795166	0.204834	1.20483	0.204834
2.20483	1.20483	-1.79517	0.204834	-0.795166	-1.79517	-0.795166
1.20483	0.204834	1.20483	-0.795166	-0.795166	-0.795166	-0.795166
0.204834	0.204834	1.20483	-2.79517	-3.79517	1.20483	-0.795166
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0.204834	1.20483	0.204834	-1.79517	0.204834	1.20483	1.20483
2.20483	-0.795166	-0.795166	0.204834	2.20483	2.20483	-0.795166
1.20483	-0.795166	0.204834	1.20483	1.20483	-1.79517	0.204834
1.20483	1.20483	1.20483	0.204834	0.204834	1.20483	1.20483
1.20483	-0.795166	0.204834	0.204834	2.20483	0.204834	-0.795166
0.204834	-0.795166	-0.795166	0.204834	0.204834	-0.795166	-0.795166
-0.795166	0.204834	-0.795166	-1.79517	-1.79517	-0.795166	-1.79517
-0.795166	-0.795166	-1.79517	-0.795166	0.204834	-0.795166	1.20483
-0.795166	-0.795166	-0.795166	0.204834	-0.795166	-0.795166	-1.79517
-0.795166	1.20483	0.204834	-0.795166	-0.795166	-1.79517	0.204834
-2.79517	0.204834	-0.795166	-0.795166	-0.795166	0.204834	-1.79517
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1.20483	0.204834	-0.795166	0.204834	0.204834	0.204834	-0.795166
0.204834	-0.795166	0.204834	-0.795166	1.20483	0.204834	0.204834
3.20483	0.204834	-1.79517	0.204834	1.20483	1.20483	-0.795166
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2

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0.204834	-0.795166	-0.795166	-0.795166	-0.795166	-0.795166	0.204834
0.204834	-0.795166	1.20483	-0.795166	-1.79517	-1.79517	-0.795166
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0.204834	0.204834	-1.79517	1.20483	2.20483	0.204834	-0.795166
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0.204834	-0.795166	0.204834	-0.795166	0.204834	1.20483	2.20483
0.204834	-0.795166	-0.795166	2.20483	2.20483	0.204834	-0.795166
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3

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1.20483	-1.79517	0.204834	1.20483	1.20483	1.20483	1.20483
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1.20483	1.20483	0.204834	0.204834	0.204834	1.20483	1.20483
0.204834	-1.79517	0.204834	0.204834	0.204834	1.20483	-0.795166
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1.20483	0.204834	-0.795166	-0.795166	1.20483	-0.795166	-0.795166
0.204834	0.204834	1.20483	2.20483	-0.795166	0.204834	0.204834
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1.20483	-1.79517	-0.795166	1.20483	4.20483	1.20483	0.204834
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1.20483	1.20483	0.204834	1.20483	-0.795166	0.204834	0.204834
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0.204834	0.204834	1.20483	2.20483	0.204834	-0.795166	-0.795166
0.204834	1.20483	2.20483	0.204834	-0.795166	-0.795166	1.20483
0.204834	-1.79517	-1.79517	0.204834	-0.795166	0.204834	0.204834
0.204834	-0.795166	0.204834	1.20483	-0.795166	0.204834	-0.795166
0.204834	0.204834	0.204834	-1.79517	-0.795166	0.204834	0.204834
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-0.795166	-0.795166	-0.795166	-0.795166	0.204834	1.20483	0.204834
0.204834	-0.795166	0.204834	1.20483	0.204834	-0.795166	-0.795166
-0.795166	-1.79517	-0.795166	-1.79517	-1.79517	0.204834	2.20483
1.20483	1.20483	1.20483	0.204834	-2.79517	-2.79517	-1.79517
0.204834	0.204834	2.20483	2.20483	1.20483	0.204834	-2.79517
-8.79517	-9.79517	-6.79517	2.20483	15.2048	30.2048	32.2048
19.2048	-9.79517	-45.7952	-69.7952	-70.7952	-37.7952	19.2048
78.2048	111.205	108.205	55.2048	-22.7952	-97.7952	-137.795
-124.795	-64.7952	17.2048	92.2048	134.205	121.205	67.2048
-9.79517	-79.7952	-113.795	-105.795	-60.7952	-1.79517	54.2048
86.2048	84.2048	56.2048	11.2048	-28.7952	-52.7952	-56.7952
-40.7952	-14.7952	9.20483	27.2048	30.2048	23.2048	8.20483
-7.79517	-17.7952	-19.7952	-12.7952	-2.79517	5.20483	13.2048
16.2048	10.2048	5.20483	-1.79517	-5.79517	-10.7952	-10.7952
-6.79517	-2.79517	1.20483	3.20483	4.20483	2.20483	-0.795166
-0.795166	0.204834	0.204834	0.204834	1.20483	1.20483	1.20483
0.204834	-1.79517	-0.795166	-2.79517	-1.79517	-3.79517	-2.79517
-2.79517	-0.795166	0.204834	1.20483	1.20483	1.20483	1.20483
3.20483	0.204834	-1.79517	0.204834	-0.795166	0.204834	-0.795166
-2.79517	-0.795166	-0.795166	1.20483	0.204834	1.20483	1.20483
-0.795166	0.204834	2.20483	0.204834	1.20483	2.20483	0.204834
-0.795166	-0.795166	0.204834	-0.795166	-0.795166	-0.795166	0.204834
1.20483	1.20483	1.20483	1.20483	0.204834	-1.79517	1.20483
3.20483	-0.795166	-1.79517	1.20483	0.204834	2.20483	1.20483
-0.795166	-2.79517	-1.79517	-0.795166	0.204834	-0.795166	0.204834
0.204834	0.204834	1.20483	1.20483	1.20483	1.20483	-1.79517
-1.79517	-0.795166	-0.795166	-1.79517	-0.795166	-2.79517	0.204834
2.20483	3.20483	3.20483	-0.795166	-3.79517	-3.79517	-1.79517
0.204834	2.20483	0.204834	-0.795166	-0.795166	-0.795166	2.20483
0.204834	0.204834	-0.795166	0.204834	0.204834	0.204834	-0.795166
-0.795166	-0.795166	0.204834	0.204834	-0.795166	-1.79517	-0.795166
-0.795166	0.204834	0.204834	-0.795166	1.20483	0.204834	0.204834
-0.795166	0.204834	-0.795166	0.204834	-0.795166	0.204834	1.20483
0.204834	0.204834	1.20483	1.20483	-0.795166	1.20483	-0.795166
0.204834	0.204834	-2.79517	0.204834	1.20483	-0.795166	-0.795166
-1.79517	1.20483	0.204834	1.20483	1.20483	-1.79517	-0.795166
0.204834	3.20483	2.20483	-0.795166	-1.79517	-1.79517	0.204834
0.204834	-0.795166	0.204834	1.20483	1.20483	1.20483	-0.795166
-1.79517	0.204834	2.20483	1.20483	-2.79517	-2.79517	-2.79517
1.20483	2.20483	2.20483	-1.79517	-3.79517	-0.795166	-0.795166
1.20483	0.204834	1.20483	0.204834	1.20483	-1.79517	-1.79517
-0.795166	-2.79517	1.20483	1.20483	-0.795166	-0.795166	-0.795166
-2.79517	-0.795166	0.204834	-0.795166	-0.795166	-0.795166	0.204834
2.20483	-0.795166	0.204834	-0.795166	1.20483	0.204834	0.204834
-1.79517	0.204834	-0.795166	0.204834	-1.79517	-0.795166	-0.795166
1.20483	3.20483	-0.795166	-5.79517	-3.79517	3.20483	6.20483
6.20483	-1.79517	-4.79517	-2.79517	-0.795166	0.204834	3.20483
3.20483	2.20483	-1.79517	-3.79517	-2.79517	-0.795166	2.20483

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4.20483	2.20483	-3.79517	-7.79517	-1.79517	3.20483	8.20483
7.20483	0.204834	-3.79517	-4.79517	-3.79517	-2.79517	0.204834
0.204834	0.204834	0.204834	-0.795166	-0.795166	-0.795166	2.20483
0.204834	-1.79517	-8.79517	-5.79517	4.20483	8.20483	8.20483
-2.79517	-3.79517	-5.79517	-2.79517	-1.79517	0.204834	5.20483
4.20483	2.20483	-0.795166	-3.79517	-1.79517	1.20483	6.20483
2.20483	-2.79517	-5.79517	-4.79517	2.20483	6.20483	5.20483
0.204834	-3.79517	-4.79517	-0.795166	-0.795166	-0.795166	0.204834
1.20483	1.20483	1.20483	-0.795166	0.204834	-2.79517	-0.795166
-1.79517	0.204834	0.204834	2.20483	2.20483	0.204834	-2.79517
-0.795166	-0.795166	1.20483	1.20483	1.20483	0.204834	-1.79517
-1.79517	0.204834	2.20483	4.20483	2.20483	-3.79517	-6.79517
-2.79517	1.20483	4.20483	9.20483	10.2048	4.20483	-4.79517
-15.7952	-22.7952	-12.7952	11.2048	32.2048	30.2048	8.20483
-22.7952	-32.7952	-22.7952	-0.795166	20.2048	30.2048	17.2048
-4.79517	-22.7952	-22.7952	-6.79517	13.2048	23.2048	13.2048
-1.79517	-17.7952	-18.7952	-3.79517	15.2048	22.2048	10.2048
-19.7952	-34.7952	-16.7952	22.2048	44.2048	33.2048	0.204834
-28.7952	-46.7952	-37.7952	-3.79517	38.2048	57.2048	40.2048
0.204834	-37.7952	-48.7952	-30.7952	11.2048	41.2048	39.2048
12.2048	-14.7952	-27.7952	-25.7952	-12.7952	2.20483	20.2048
33.2048	28.2048	6.20483	-15.7952	-28.7952	-27.7952	-16.7952
0.204834	17.2048	33.2048	35.2048	24.2048	-7.79517	-43.7952
-55.7952	-28.7952	18.2048	49.2048	49.2048	21.2048	-17.7952
-44.7952	-49.7952	-30.7952	11.2048	46.2048	60.2048	39.2048
-6.79517	-52.7952	-68.7952	-45.7952	3.20483	49.2048	61.2048
37.2048	-0.795166	-30.7952	-41.7952	-29.7952	-8.79517	12.2048
20.2048	22.2048	12.2048	2.20483	-6.79517	-11.7952	-7.79517
-5.79517	-6.79517	-0.795166	2.20483	8.20483	14.2048	8.20483
-0.795166	-5.79517	-6.79517	-5.79517	-6.79517	-8.79517	-1.79517
12.2048	27.2048	20.2048	0.204834	-20.7952	-30.7952	-22.7952
-3.79517	13.2048	26.2048	25.2048	15.2048	-5.79517	-26.7952
-29.7952	-13.7952	10.2048	22.2048	19.2048	7.20483	-4.79517
-8.79517	-1.79517	-0.795166	-6.79517	-11.7952	-6.79517	8.20483
18.2048	15.2048	2.20483	-7.79517	-10.7952	-12.7952	-9.79517
-3.79517	3.20483	11.2048	14.2048	9.20483	1.20483	-2.79517
-5.79517	-4.79517	-5.79517	-11.7952	-13.7952	-3.79517	12.2048
23.2048	20.2048	4.20483	-14.7952	-24.7952	-16.7952	-2.79517
10.2048	11.2048	1.20483	-2.79517	-3.79517	1.20483	10.2048
10.2048	-2.79517	-8.79517	-15.7952	-11.7952	-4.79517	10.2048
19.2048	17.2048	8.20483	-6.79517	-16.7952	-13.7952	-5.79517
8.20483	9.20483	8.20483	4.20483	0.204834	1.20483	2.20483
1.20483	-1.79517	-6.79517	-5.79517	-1.79517	5.20483	13.2048
12.2048	6.20483	-3.79517	-9.79517	-9.79517	-3.79517	1.20483
7.20483	11.2048	7.20483	4.20483	0.204834	-2.79517	-2.79517
-0.795166	-2.79517	-0.795166	2.20483	4.20483	4.20483	3.20483
-0.795166	-2.79517	-3.79517	-2.79517	0.204834	2.20483	3.20483
3.20483	0.204834	-0.795166	-2.79517	0.204834	2.20483	3.20483
1.20483	1.20483	-1.79517	-1.79517	-3.79517	-3.79517	-1.79517
0.204834	7.20483	8.20483	4.20483	-2.79517	-8.79517	-11.7952
-6.79517	0.204834	8.20483	8.20483	6.20483	1.20483	-7.79517
-9.79517	-8.79517	-1.79517	5.20483	7.20483	7.20483	0.204834
-3.79517	-8.79517	-1.79517	3.20483	5.20483	7.20483	-0.795166
-4.79517	-4.79517	-2.79517	1.20483	5.20483	8.20483	4.20483
-3.79517	-2.79517	-3.79517	-0.795166	3.20483	5.20483	2.20483
-1.79517	-2.79517	-1.79517	3.20483	3.20483	2.20483	-0.795166
-1.79517	-3.79517	-3.79517	-1.79517	0.204834	4.20483	5.20483
2.20483	1.20483	3.20483	4.20483	-0.795166	-7.79517	-10.7952
-6.79517	6.20483	10.2048	7.20483	1.20483	-0.795166	3.20483
1.20483	-2.79517	-9.79517	-10.7952	0.204834	11.2048	14.2048
5.20483	-3.79517	-5.79517	0.204834	1.20483	-0.795166	-8.79517
-6.79517	-1.79517	6.20483	9.20483	5.20483	-0.795166	-2.79517
-2.79517	-2.79517	-4.79517	-3.79517	-3.79517	1.20483	6.20483
2.20483	1.20483	0.204834	1.20483	-1.79517	-2.79517	-6.79517
-4.79517	2.20483	6.20483	6.20483	3.20483	-1.79517	-3.79517
-5.79517	-1.79517	1.20483	2.20483	1.20483	3.20483	-0.795166
0.204834	-1.79517	-1.79517	0.204834	3.20483	2.20483	0.204834
-0.795166	0.204834	-0.795166	-1.79517	-1.79517	-2.79517	-0.795166

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1.20483	3.20483	4.20483	3.20483	2.20483	-1.79517	-3.79517
-5.79517	-3.79517	0.204834	4.20483	5.20483	6.20483	2.20483
-2.79517	-4.79517	-3.79517	-1.79517	1.20483	4.20483	3.20483
2.20483	-1.79517	-0.795166	0.204834	2.20483	2.20483	3.20483
-0.795166	-6.79517	-6.79517	-1.79517	0.204834	6.20483	7.20483
5.20483	1.20483	-4.79517	-7.79517	-7.79517	-3.79517	1.20483
6.20483	6.20483	3.20483	1.20483	-1.79517	-4.79517	-6.79517
-4.79517	-1.79517	3.20483	4.20483	5.20483	6.20483	-0.795166
-2.79517	-5.79517	-5.79517	-3.79517	1.20483	3.20483	6.20483
5.20483	3.20483	-2.79517	-3.79517	-3.79517	-2.79517	-0.795166
2.20483	4.20483	4.20483	6.20483	1.20483	-2.79517	-4.79517
-2.79517	-0.795166	3.20483	3.20483	2.20483	0.204834	-2.79517
-0.795166	-0.795166	1.20483	3.20483	3.20483	2.20483	-1.79517
-2.79517	-2.79517	0.204834	2.20483	3.20483	2.20483	1.20483
-1.79517	-1.79517	2.20483	-0.795166	-0.795166	1.20483	2.20483
3.20483	1.20483	0.204834	-1.79517	-0.795166	0.204834	0.204834
0.204834	0.204834	0.204834	0.204834	0.204834	-0.795166	0.204834
2.20483	1.20483	1.20483	-0.795166	-3.79517	-0.795166	0.204834
1.20483	1.20483	1.20483	0.204834	0.204834	1.20483	3.20483
2.20483	-2.79517	-4.79517	-4.79517	2.20483	5.20483	7.20483
3.20483	-0.795166	-4.79517	-5.79517	-3.79517	0.204834	2.20483
5.20483	6.20483	3.20483	-3.79517	-5.79517	-2.79517	0.204834
3.20483	2.20483	2.20483	1.20483	0.204834	-0.795166	0.204834
1.20483	-0.795166	-0.795166	-0.795166	0.204834	2.20483	1.20483
0.204834	-0.795166	0.204834	-0.795166	-1.79517	-0.795166	1.20483
0.204834	2.20483	-1.79517	0.204834	-1.79517	0.204834	-0.795166
-1.79517	-0.795166	-0.795166	1.20483	0.204834	2.20483	-0.795166
-0.795166	0.204834	-2.79517	-0.795166	1.20483	1.20483	3.20483
2.20483	-1.79517	-1.79517	-0.795166	-3.79517	-0.795166	1.20483
1.20483	2.20483	0.204834	-1.79517	-0.795166	-2.79517	-0.795166
-2.79517	-0.795166	-0.795166	1.20483	1.20483	1.20483	-0.795166
-2.79517	-2.79517	0.204834	0.204834	1.20483	1.20483	1.20483
1.20483	-0.795166	-2.79517	-2.79517	-1.79517	2.20483	3.20483
4.20483	3.20483	0.204834	-1.79517	-0.795166	0.204834	0.204834
2.20483	2.20483	2.20483	1.20483	0.204834	1.20483	0.204834
1.20483	0.204834	1.20483	-0.795166	0.204834	0.204834	-1.79517
-0.795166	-0.795166	0.204834	2.20483	1.20483	1.20483	0.204834
0.204834	-0.795166	0.204834	2.20483	3.20483	2.20483	-0.795166
4.20483	-0.795166	-0.795166	0.204834	-0.795166	0.204834	0.204834
0.204834	0.204834	-0.795166	2.20483	2.20483	1.20483	0.204834
-2.79517	-4.79517	2.20483	2.20483	0.204834	1.20483	1.20483
-0.795166	-2.79517	-2.79517	-1.79517	0.204834	2.20483	3.20483
1.20483	-2.79517	-1.79517	1.20483	0.204834	3.20483	-0.795166
-0.795166	-1.79517	1.20483	2.20483	-0.795166	-0.795166	-0.795166
0.204834	2.20483	1.20483	0.204834	0.204834	0.204834	1.20483
0.204834	-0.795166	-0.795166	0.204834	-0.795166	0.204834	1.20483
1.20483	1.20483	2.20483	-0.795166	-2.79517	-0.795166	-0.795166
0.204834	-0.795166	0.204834	0.204834	-0.795166	-0.795166	0.204834
0.204834	-0.795166	0.204834	2.20483	-0.795166	2.20483	1.20483
-1.79517	-0.795166	0.204834	-0.795166	2.20483	3.20483	-0.795166
-0.795166	-1.79517	-2.79517	-1.79517	-0.795166	2.20483	2.20483
3.20483	-0.795166	-1.79517	-2.79517	-2.79517	-0.795166	0.204834
1.20483	0.204834	0.204834	-0.795166	0.204834	-1.79517	-1.79517
-1.79517	1.20483	1.20483	-0.795166	-0.795166	-2.79517	-2.79517
1.20483	1.20483	1.20483	-0.795166	-1.79517	0.204834	-0.795166
0.204834	0.204834	-0.795166	0.204834	0.204834	0.204834	1.20483
1.20483	-0.795166	0.204834	-0.795166	0.204834	0.204834	0.204834
0.204834	0.204834	0.204834	-0.795166	0.204834	-1.79517	0.204834
0.204834	1.20483	0.204834	0.204834	-2.79517	0.204834	1.20483
0.204834	-0.795166	0.204834	1.20483	1.20483	0.204834	-0.795166
-0.795166	0.204834	1.20483	0.204834	-0.795166	-1.79517	0.204834
1.20483	0.204834	-0.795166	0.204834	2.20483	2.20483	0.204834
-0.795166	-0.795166	-1.79517	-0.795166	1.20483	2.20483	1.20483
1.20483	0.204834	-0.795166	-0.795166	-0.795166	-0.795166	-0.795166
0.204834	1.20483	1.20483	0.204834	-0.795166	-0.795166	-0.795166
0.204834	-0.795166	-1.79517	-0.795166	0.204834	-0.795166	0.204834
-1.79517	0.204834	0.204834	0.204834	-0.795166	0.204834	-0.795166
-0.795166	1.20483	0.204834	-0.795166	1.20483	-0.795166	-0.795166

0.204834	1.20483	-0.795166	-0.795166	-0.795166	2.20483	-1.79517
1.20483	0.204834	0.204834	0.204834	0.204834	-0.795166	-0.795166
-0.795166	1.20483	0.204834	0.204834	-1.79517	0.204834	0.204834
-0.795166	-0.795166	-0.795166	0.204834	0.204834	1.20483	0.204834
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1.20483	-0.795166	0.204834	0.204834	2.20483	-0.795166	-0.795166
2.20483	1.20483	2.20483	-0.795166	-0.795166	0.204834	0.204834
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-0.795166	1.20483	0.204834	2.20483	-0.795166	-0.795166	2.20483
0.204834	0.204834	-0.795166	-0.795166	-0.795166	-1.79517	-2.79517
-1.79517	2.20483	3.20483	5.20483	2.20483	-2.79517	-5.79517
-5.79517						